CERES instruments special coverage for field campaigns

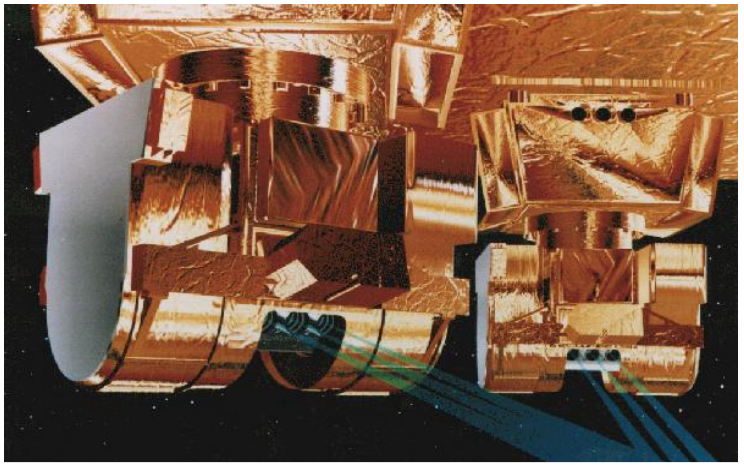
Z. Peter Szewczyk
Kory J. Priestley

ISRSE Conference, Honolulu, 11/10-14, 2003

Presentation Outline

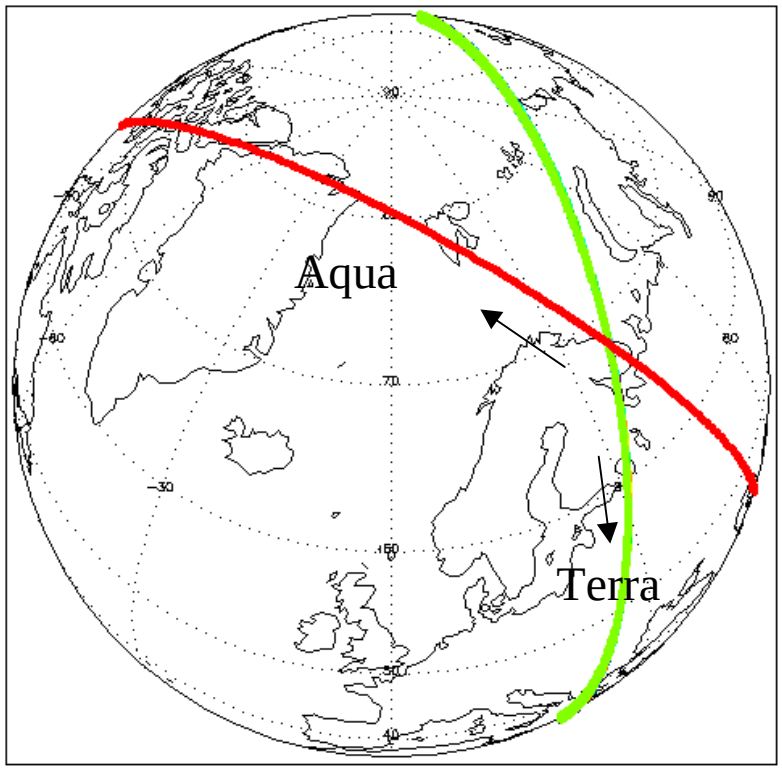
- CERES instruments
- Special mode for observing Earth targets
- Planning tools
- Field campaigns involving CERES
- Conclusions

Clouds and the **E**arth's **R**adiant **E**nergy **S**ystem Instrument



- Narrow field-of-view (15x30km at nadir) scanning radiometer:
  - Shortwave channel (0.3-5μm),
  - Total channel (0.3-100μm),
  - Window channel (8-12μm)
- PFM on board TRMM (1998, failed 06/2000)
- FM1 & FM2 on board Terra (in service from 03/2000)
- FM3 & FM4 on board Aqua (in service from 06/2002)

Terra & Aqua orbits



- Sun-synchronous, inclination angle 98.2º and 81.8º
- Equator crossing time: 10:30AM and 1:30PM
- about 15 minutes apart at nodes

PAPS mode

Normal operation modes:

- Cross-track (XT) scan
- Rotational Azimuth Plane Scan (RAPS)

Programmable Azimuth Plane Scan:

- Scanning Plane follows a prescribed schedule
- Meets requirements for special observations
- Increases sampling by an order of magnitude

Field campaigns with CERES

Four campaigns with both satellites and a well defined Earth target:

- Terra-Aqua (FM1-FM4) validation
- Cirrus cloud (CRYSTAL-FACE) properties
- Ultra-long Duration Balloon (ULDB) direct flux measurements
- Ground validation for GERB (SCALES) at Valencia Anchor Station

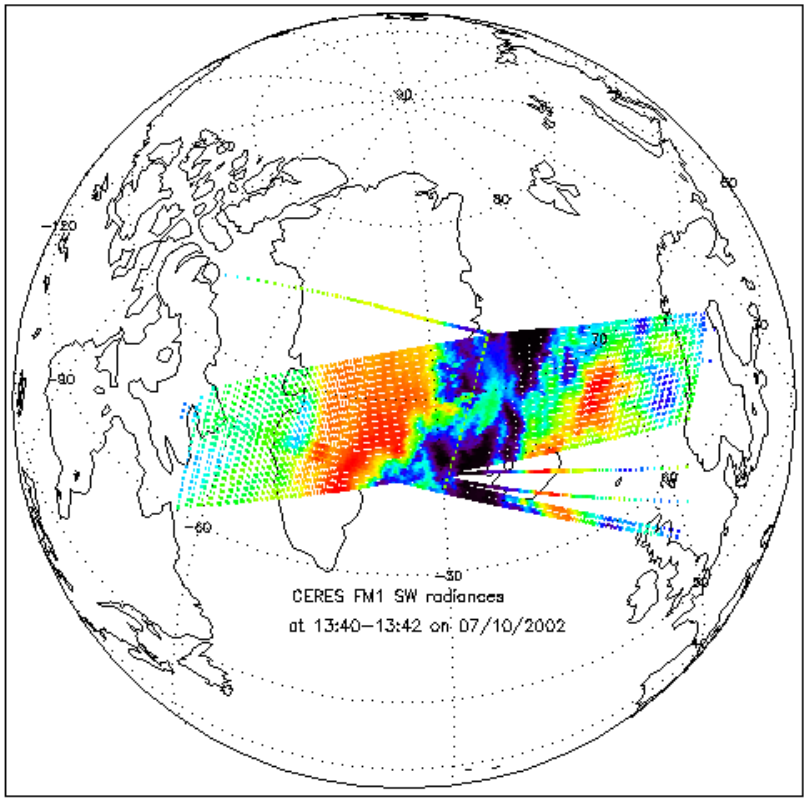
1. FM1-FM4 validation

Two-decade long Earth's radiation budget dataset

- Greenland is the most homogenous:
  - FM1 and FM4 15 minutes apart
  - Scans orthogonal to the solar plane
- Validation campaign:
  - 07/04 – 08/22, 2002
  - 1,000 orbital crossings of about 90 seconds each
  - Significant amount of data for statistical analysis

FM1 scan over Greenland

Unfiltered shortwave radiances at 13:40 on 07/10/2002

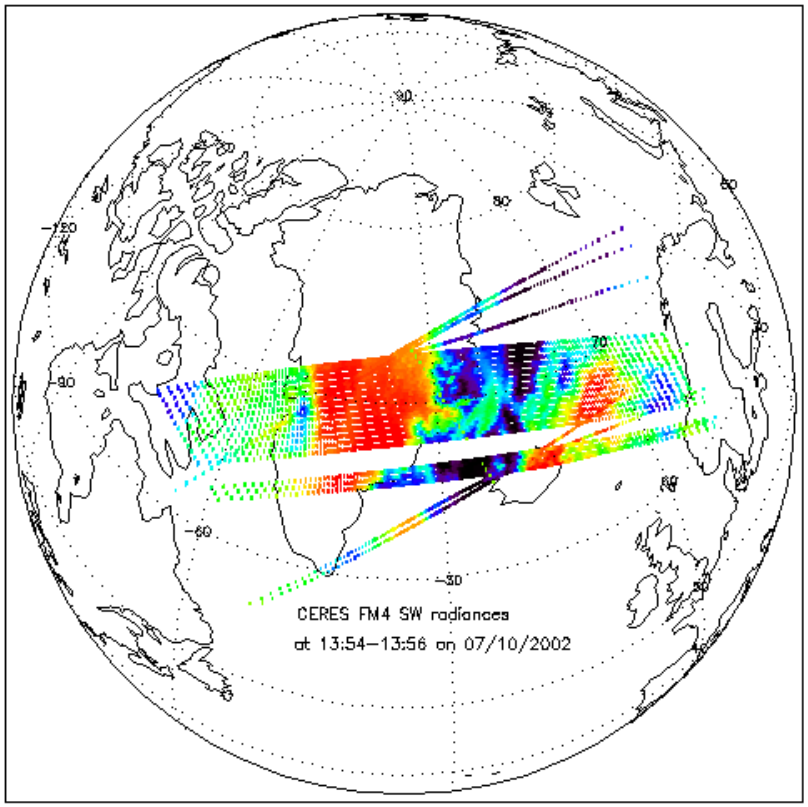


0 100 203

Watts per square meter per steradian

FM4 scan over Greenland

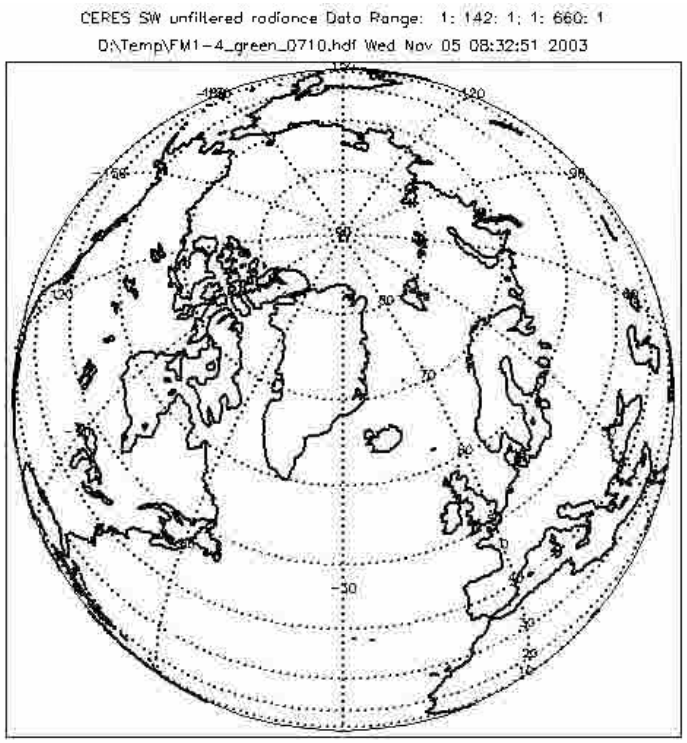
Unfiltered shortwave radiances at 13:54 on 07/10/2002



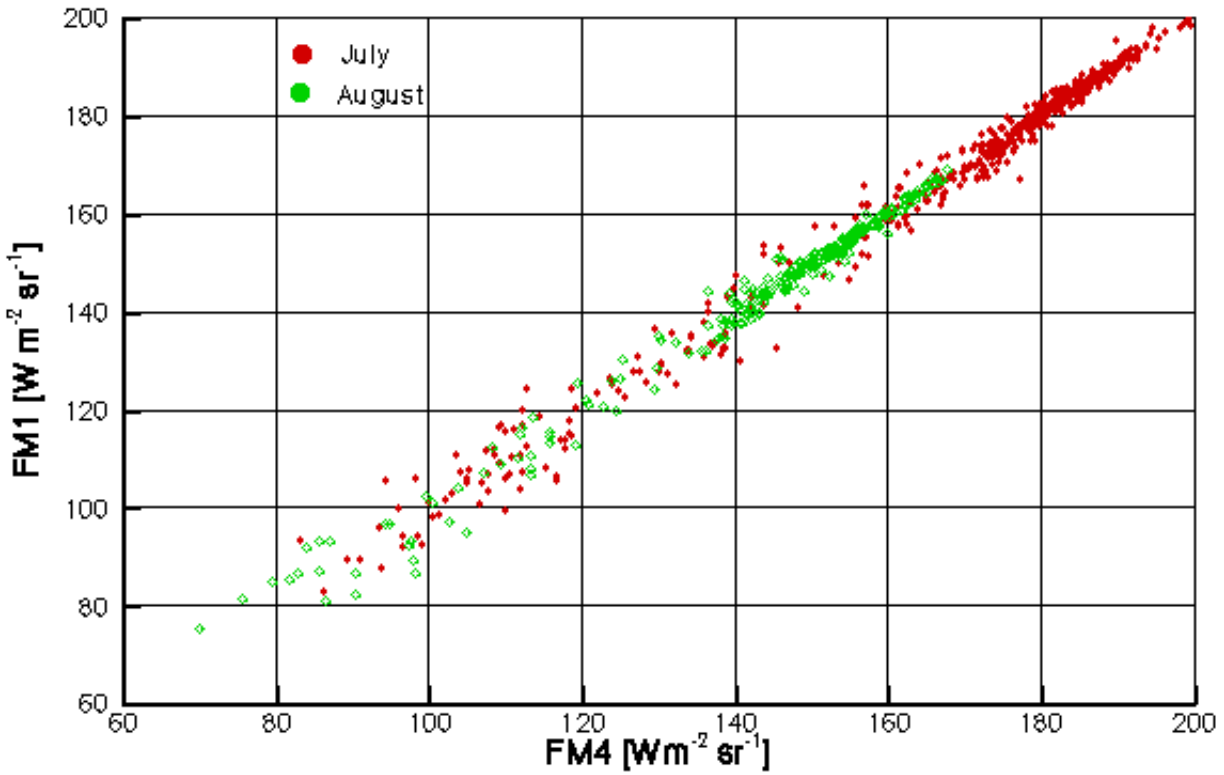
0 100 200

Watts per square meter per steradian

FM1 and FM4 over Greenland



SW radiances over Greenland



Results for FM1-FM4

Radiance	Mean FM4 [$Wm^{-2}sr^{-1}$]	Δ mean [$Wm^{-2}sr^{-1}$]	Δ mean %	Δσ [$Wm^{-2}sr^{-1}$]	N_{orbX}	α–test
SW	159.1	0.24	**0.15**	1.05	72	**0.3**

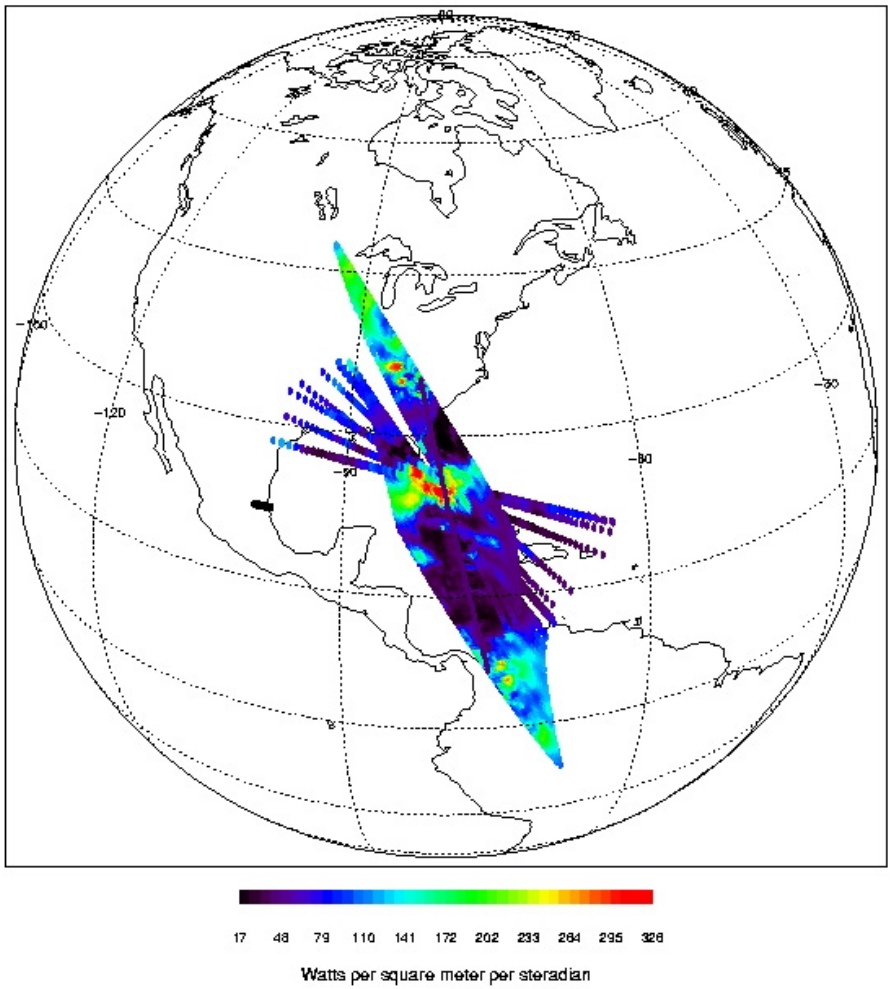
- Data analysis fully demonstrated the 1% consistency in radiance measurements
- CERES instruments have delivered a high quality radiation budget data set since 1998

2. Cirrus cloud properties
(CRYSTAL-FACE)

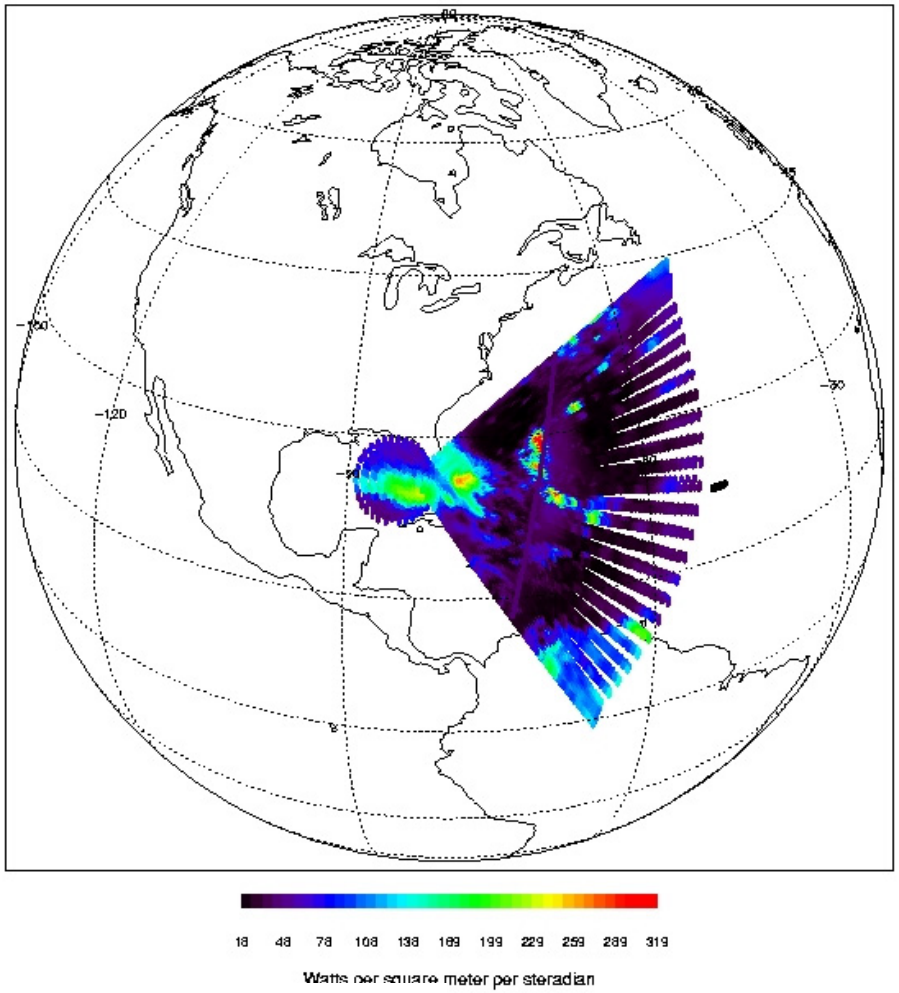
Detailed measurements of clouds for climate models

- Joint effort of six aircrafts, ground radars and lidars, CERES
- Miami site:
  - FM2 on Terra and FM3 on Aqua
  - 50 km wide swath over the site
- Validation campaign:
  - July 6 – 29, 2002
  - 40 Terra and 30 Aqua passes of about 5 minutes each

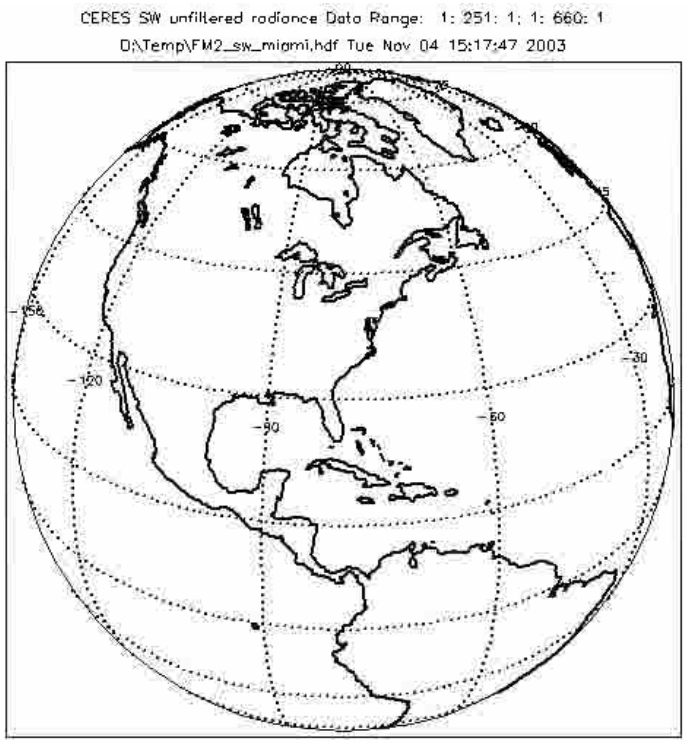
FM3 scan over Miami



FM2 scan over Miami



FM2 scan over Miami



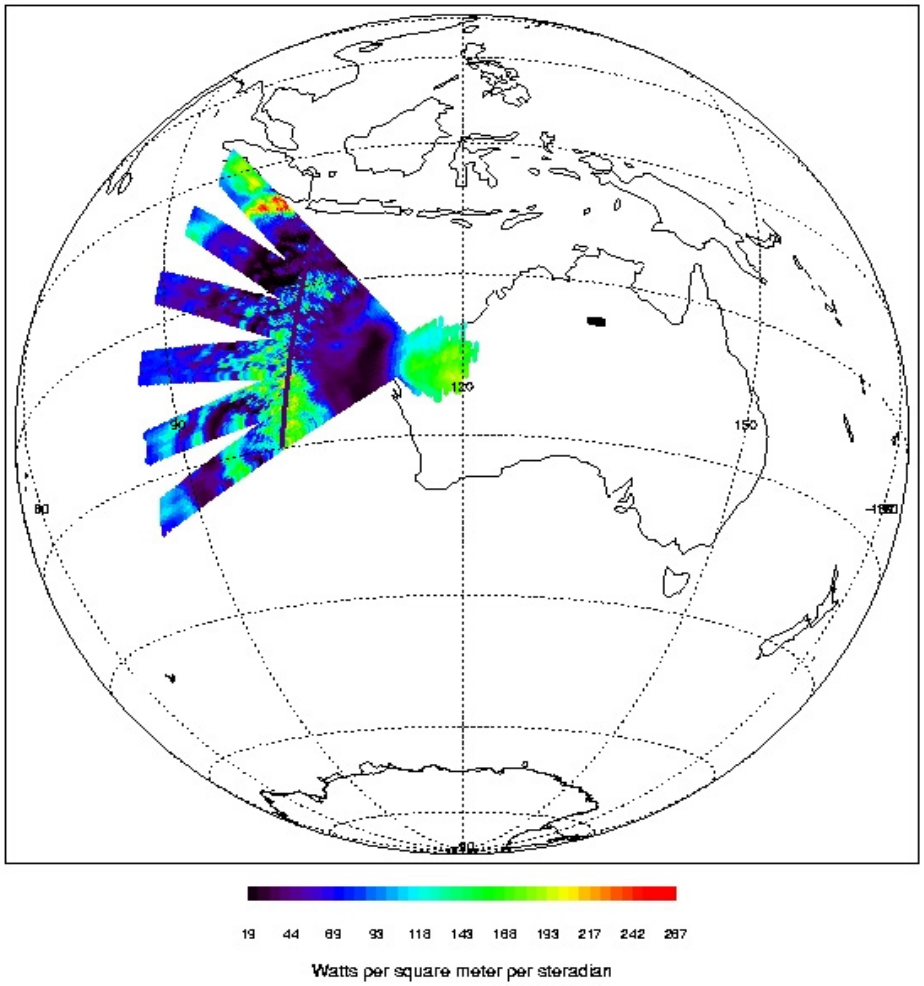
3. Direct flux measurements

(ULDB)

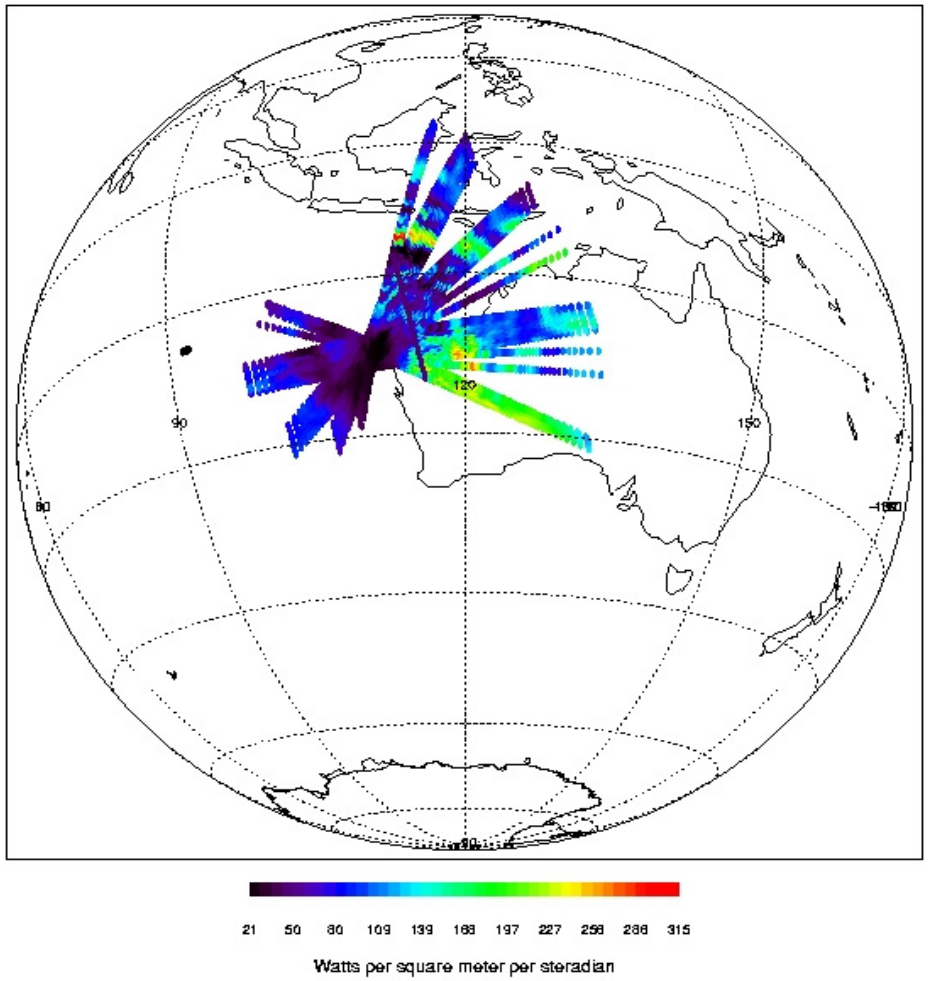
To measure SW and LW fluxes (TOA) at 1% level

- Ultra-long-duration balloon
  - 120 m in diameter with pyranometers and pyrgeometers
  - 35 km high at 30 m/s for 100 days
- Launched from Alice Springs, Au, Feb.2003:
  - FM2 on Terra and FM4 on Aqua
  - 150 km wide swath over a predicted balloon location

FM2 scan over balloon



FM4 scan over balloon

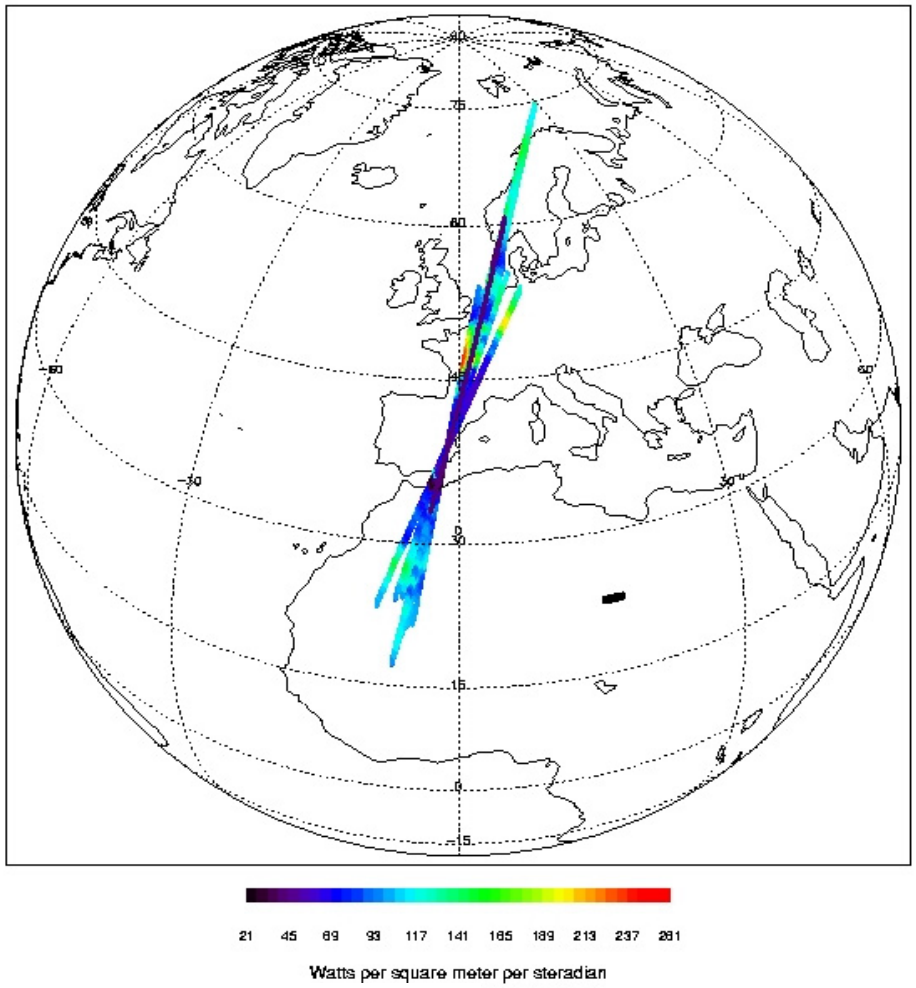


4. GERB ground validation
(SCALES)

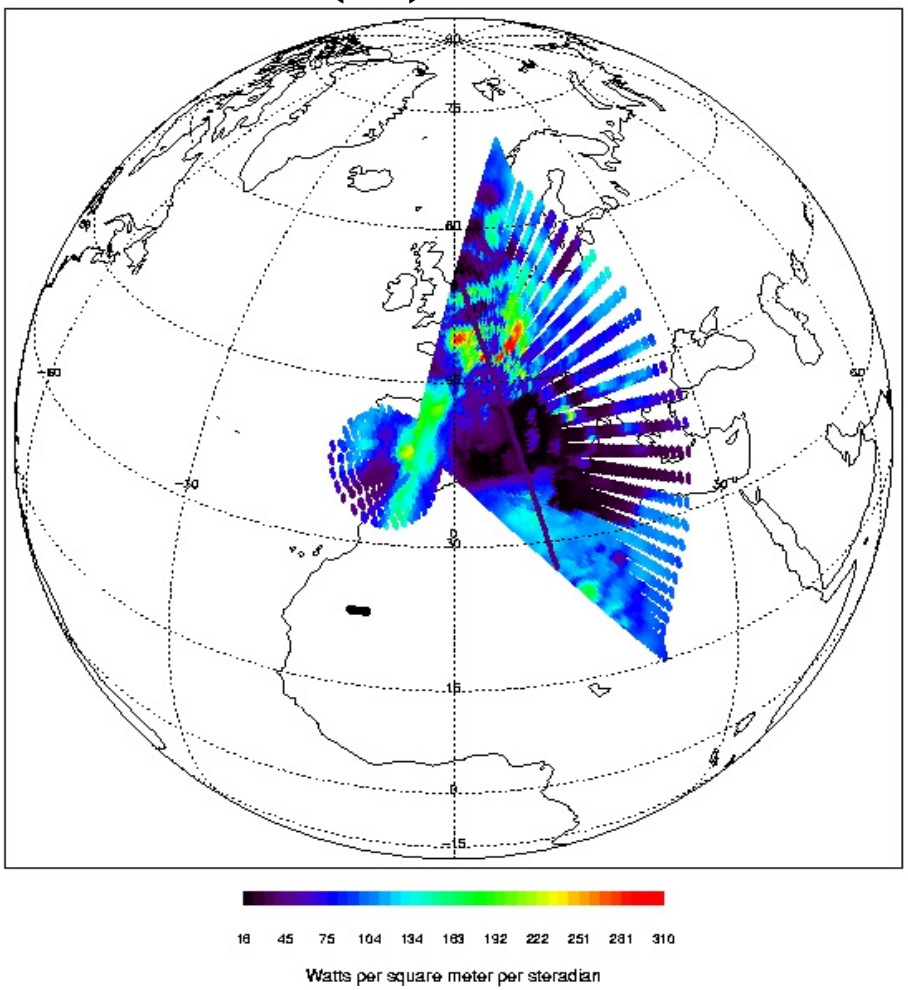
To validate GERB radiances with ground data

- **G**eo **E**arth **R**adiation **B**udget instrument with 256 detectors
- Valencia Anchor Station (VAS): 39.34^{o}N and 1.17^{o}W
  - GERB pixel size (50x50 km) and quite homogenous
  - Lidar, sunphotometers, pyranometers, etc.
- CERES measurements on June 14, 18-24, and 30, 2003:
  - FM2 on Terra and FM4 on Aqua
  - 50 km wide swath (2 scans) for about 5 minutes

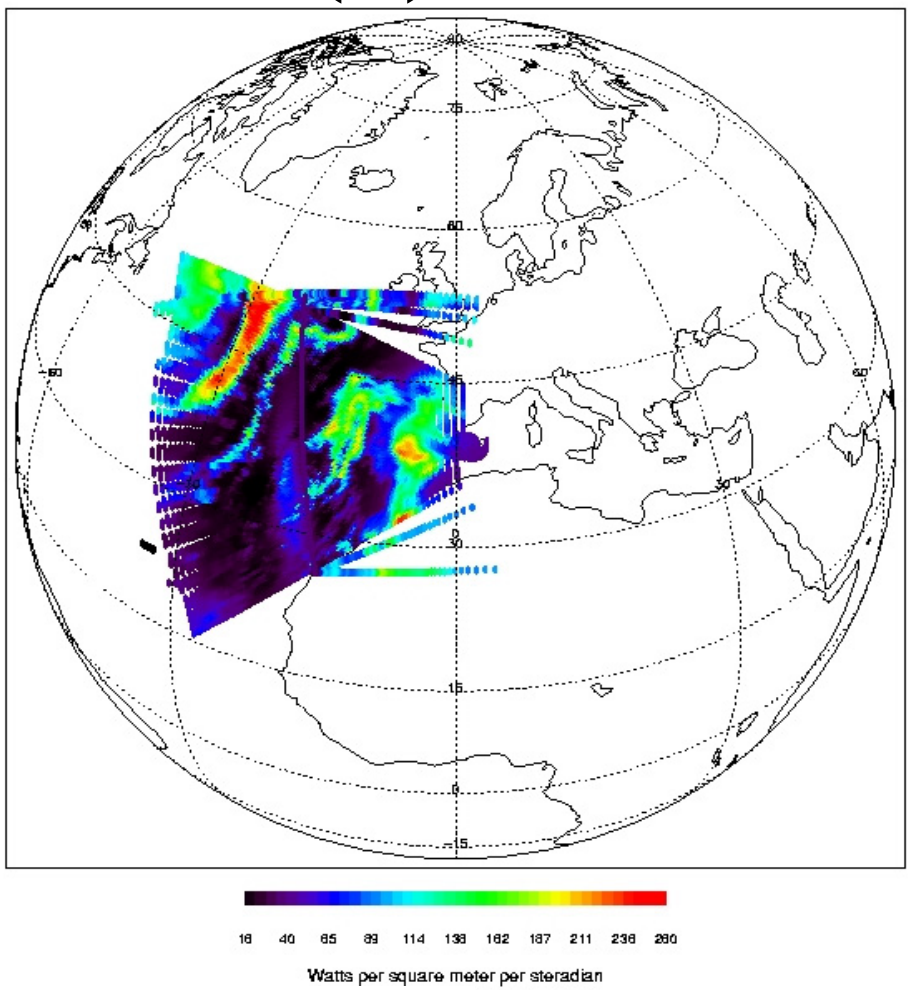
FM2 scan over Valencia



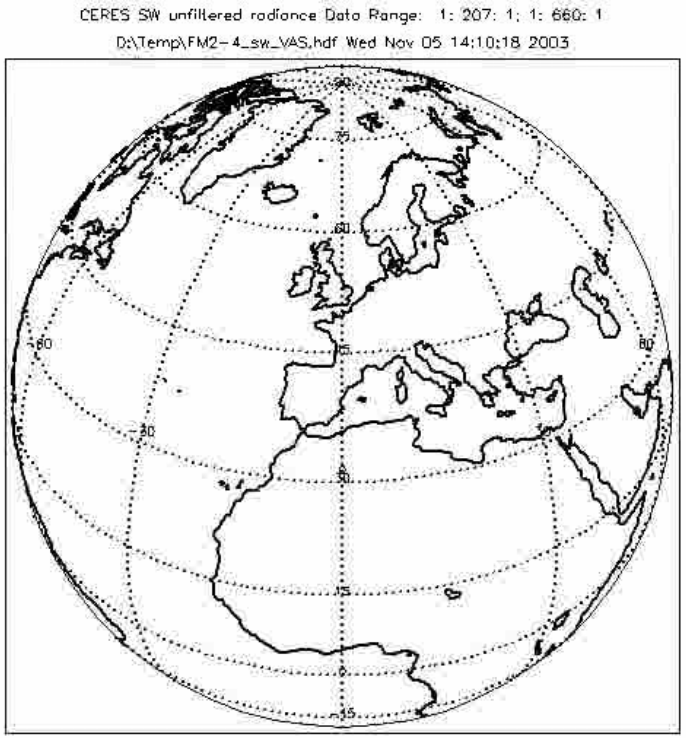
FM4 scan (1) over Valencia



FM4 scan (2) over Valencia



FM2-FM4 scan over VAS



Concluding remarks

- CERES participated in variety of campaigns
- PAPS mode for observing Earth targets
- Planning tools reside on the website
- Free service to the science community

http://asd-www.larc.nasa.gov/PAPS/cgi-bin/rygar.cgi